



Montana
Office of Public Instruction
Denise Juneau, State Superintendent

opi.mt.gov

Mathematics Model Teaching Unit

Montana Native American Population

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Grade 11 – Approximate Duration: 100 minutes

Stage 1 Desired Results

Established Goals:

Data Analysis Mathematics Content Standard 2: A student, applying reasoning and problem solving, will use data representation and analysis, simulations, probability, statistics, and statistical methods to evaluate information and make informed decisions within a variety of relevant cultural contexts, including those of Montana American Indians.

- **2.1 Representing and Analyzing Data:** Select, create, and compare graphical or numerical representations of data sets using technology when appropriate. Reason about distributions using measures of central tendency and spread (e.g., percentiles, quartiles, inter-quartile range, and standard deviation).
- **2.5 Curve Fitting:** Model two-variable data using curve fitting with and without technology. Write an equation for a given model and decide when or if predictions based on this equation are valid.

IEFA: Essential Understanding 4: Reservations are lands that have been reserved by the tribes for their own use through treaties, statutes, and executive orders and were not “given” to them. The principle that land should be acquired from the Indians only through their consent with treaties involved three assumptions:

I. Both parties to treaties were sovereign powers.

II. Indian tribes had some form of transferable title to the land.

III. Acquisition of Indian lands was solely a government matter not to be left to individual colonists.

IEFA: Essential Understanding 7: Under the American legal system, Indian tribes have sovereign powers, separate and independent from the federal and state governments. However, the extent and breadth of tribal sovereignty is not the same for each tribe.

Understandings:

Students will understand...

- how to create a scatter plot to show the population trend of the American Indian Population on or around a reservation.
- how to create a scatter plot to show the total population trend on or around a reservation.

Essential Questions:

- What changes have occurred in the American Indian population over the years 2000-2006?
- What changes have occurred in the total population over the years 2000-2006?
- How do the changes compare for the two different populations?



<p><i>Mathematics Grade 11 – Montana Native American Population (continued)</i></p> <ul style="list-style-type: none"> • how to look for trends associated with the scatter plot and a model that fits the trend. • how to make predictions to the future population using their model. • how to calculate a residual value for a data set. 	<ul style="list-style-type: none"> • Is there more than one type of model that could fit a data set? • How do we decide if a model is a reasonable model for a data set?
<p><i>Students will be able to...</i></p> <ul style="list-style-type: none"> • create a scatter plot representing the population data of the American Indians and total population for all Montana reservations and their related areas. • find a model that best fits the data either by hand or using appropriate technology. • make predictions using their model. • create a residual plot for a data set. 	<p><i>Students will know...</i></p> <ul style="list-style-type: none"> • how to create a scatter plot and analyze the trend represented by the data. • how to use their model to make predictions. • how to use residual plots to decide if a model is a good fit.

Stage 2 Assessment Evidence

Performance Tasks: Graphs and models for data sets of American Indian and total population for MT reservations and their related areas. Worksheet with questions answered and turned in.

Other Evidence: Participation with group discussion. Observation of students' graphs and method of finding their model to fit the data. Individual questioning of students.

Stage 3 Learning Plan

Learning Activities:

1. State the "Understandings" for the lesson.
2. Introduction Activity. Divide class into eight groups. Hand out Demographic & Economic information pamphlets for each Montana Reservation, as well as the pamphlet for the Little Shell tribe. Each student in the group receives one for the reservation or tribe they have been assigned. After students have had a few minutes to review their information, ask the class the following questions:
 - Are the values reported for all counties on the reservation or around the tribes? If not, why do you think this is the case? (This is a discussion generating question and will not have an absolute response.)
 - Does the American Indian population for the reported counties tend to increase or decrease?
 - Does the total population for the same reported counties tend to increase or decrease?
3. Complete questions #1- #4 on student worksheet.
4. Have each group post their scatter plots around the room so that they are visible for the entire class.
 - What type of model(s) best represents the data change?
 - With what we know about populations, what type of model best fits this trend?
5. Complete questions #5 - #6 on student worksheet.
6. Have each group write their model of best fit along side the corresponding scatter plot.
 - What is common about the given models?
 - What is different?

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7. Complete questions #7 - #10 on student worksheet.
8. Turn in worksheet.

Summary: You have created a graph to represent the change in American Indian population near reservations and total populations of the same area. After analyzing the trend represented by your graph, you determined a model that could be used to make predictions about the population in the next few years.

Materials/Resources Needed:

- Copies of the Demographic & Economic information for the seven MT reservations and the Little Shell tribe, for each student. The State of Montana site, (<http://www.ourfactsyourfuture.org/cgi/databrowsing/?PAGEID=4&SUBID=249>) offers very nice printable pamphlets to use.
- Graph paper or large paper to create scatter plot on. Scatter plots could be created on a type of technology that can be shown to all students via a view screen or Smartboard.
- Graphing utility or device capable of calculating the best fit model.

Extensions: This lesson could focus on the population percentage of American Indians by age group and the population percentage of Montanans by age group. The data can be modeled by a logistic function for both each tribe compared to the Montanan percentage. Discussing with students why the same type of model would not work for this data, could lead to interesting comments.

Student Worksheet
Montana Reservation Population

Name_____

Reservation_____

1. Create a scatter plot representing the data for the American Indian Population for the years 2000-2006.
2. Explain the trend you see exists with your data sets?
3. Create a scatter plot representing the data for the total population for the years 2000-2006.
4. Does the same trend exist for the total population as did in the American Indian population? Compare and contrast the trends.
5. What possible model(s) would best fit your population? Determine the model for each of your data sets. Be sure to write your model in the correct form.
6. Determine the predicted population values for the years 2000-2006 using the models found in question #5. Use the predicted values to calculate the residuals for your data sets.
7. What does a negative residual value mean? What does a positive residual value mean?
8. Create a residual plot for the American Indian population and a separate residual plot for the total population. Do the residual plots indicate that your models are a reasonable model?
9. Use your model(s) to predict the population(s) of the American Indian and total for **2007**. Should we use our model to predict for the year **2012**?
10. Create a residual plot for a different type of model that “may” fit the data sets. Which model is the best fit after looking at your different residual plots?

Student Worksheet (Key)
Montana Reservation Population

Name _____

Reservation _____

1. Create a scatter plot representing the data for the American Indian Population for the years 2000-2006.

Scatter plots vary depending upon the tribe of focus. It is important that the plots are easily read by the entire class. The scatter plot could be created on a graphing calculator and then displayed on an overhead view screen or Smartboard if available.

2. What trend do you see exists with your data set?

Generally speaking the tribal populations are increasing. Some of the total populations are increasing and others are decreasing.

3. Create a scatter plot representing the data for the total population for the years 2000-2006.

4. Does the same trend exist for the total population as did in the American Indian population? Compare and contrast the trends.

This response will be dependent upon their specific tribe of focus.

5. What possible model(s) would best fit your populations? Determine the model for each of your data sets. Be sure to write your model in the correct form.

Some students will believe that the data looks very linear since it is for such a small amount of time. Others will believe that it represents an exponential model since we have an initial population and then percentage of change.

6. Determine the predicted population values for the years 2000-2006 using the models found in question #5. Use the predicted values to calculate the residuals for your data sets.

7. What does a negative residual value mean? What does a positive residual value mean?

A negative residual means the predicted value is larger than the actual value. A positive residual value means the predicted value is smaller than the actual value.

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8. Create a residual plot for the American Indian population and a separate residual plot for the total population. Do the residual plots indicate that your models are reasonable?

If the residual plot (x-value, residual) has the points randomly scattered above and below the x-axis, this graph indicates that a reasonable model has been selected.

9. Use your model(s) to predict the population(s) of the American Indian and total for **2007**. Should we use our model to predict for the year **2012**?

These values will depend upon the model used. Predicting outside of our data set is not a good practice, especially with an exponential model.

10. Create a residual plot for a different type of model that “may” fit the data sets. Which model is the best fit after looking at your different residual plots?

As stated in question #5, some students will try a linear model here.

This table represents the possible exponential models for the American Indian Population by reservation and for the total population.

Reservation (American Indian Population)	Exponential Model
Fort Peck	$y = 6657.5 * 1.008^x$
Fort Belknap	$y = 3444.5 * 1.0009^x$
Blackfeet	$y = 8928.8 * 1.007^x$
Northern Cheyenne	$y = 10523.7 * 1.009^x$
Rocky Boy's	$y = 3738.1 * 1.01^x$
Flathead	$y = 9972.8 * 1.013^x$
Crow	$y = 11574.3 * 1.02^x$
Reservation (Total Population)	Exponential Model
Fort Peck	$y = 24278 * 0.99^x$
Fort Belknap	$y = 11490 * 0.987^x$
Blackfeet	$y = 19533.7 * 1.0004^x$
Northern Cheyenne	$y = 22042 * 1.002^x$
Rocky Boy's	$y = 22426.5 * 0.99^x$
Flathead	$y = 208630 * 1.012^x$
Crow	$y = 141820 * 1.011^x$

Here is some teacher Information regarding the total population and American Indian population by related areas. The percentage change of both the American Indian population and total population is indicated along with the average percentage of change by Reservation.

<http://www.ourfactsyourfuture.org/cgi/databrowsing/?PAGEID=4&SUBID=249>

Reservation	Year	American Indian Pop.	Percentage Change	Total Population	Percentage Change
Fort Peck Related Areas: Counties of Daniels, Roosevelt, Sheridan, and Valley	2000	6679	1.32%	24417	-1.45%
	2001	6767	-0.93%	24064	-2.09%
	2002	6704	0.81%	23562	-1.25%
	2003	6758	1.97%	23267	0.25%
	2004	6891	1.86%	23326	-1.02%
	2005	7019	-0.44%	23087	-1.62%
	2006	6988	(average) 0.76%	22712	(average) -1.20%
Fort Belknap Related Areas: Counties of Blaine and Phillips	2000	3502	-2.28%	11610	-2.93%
	2001	3422	0.15%	11270	-0.91%
	2002	3427	-0.03%	11167	-1.32%
	2003	3426	0.18%	11020	-1.23%
	2004	3432	1.19%	10884	-1.06%
	2005	3473	0.63%	10769	-0.52%
	2006	3495	(average) -0.03%	10713	(average) -1.33%

Northern Cheyenne and Related Areas: Counties of Big Horn and Rosebud	2000	10539	0.98%	22054	0.16%
	2001	10642	0.38%	22090	0.06%
	2002	10682	0.64%	22104	0.37%
	2003	10750	1.69%	22186	0.44%
	2004	10932	1.49%	22284	0.32%
	2005	11095	-0.23%	22355	-0.26%
	2006	11069	(average) 0.82%	22296	(average) 0.18%
Rocky Boy's and Related Areas: Counties of Choteau and Hill	2000	3736	1.98%	22643	-1.52%
	2001	3810	-0.45%	22299	-1.37%
	2002	3793	1.11%	21994	-0.70%
	2003	3835	1.36%	21840	0.17%
	2004	3887	1.21%	21877	-0.63%
	2005	3934	1.40%	21740	0.37%
	2006	3989	(average) 1.10%	21820	(average) -0.61%
Flathead and Related Areas: Counties of Flathead, Lake, Missoula, Sanders	2000	9970	1.46%	211048	-0.40%
	2001	10116	0.90%	210200	1.17%
	2002	10207	1.43%	212662	1.38%
	2003	10353	1.31%	215600	1.52%
	2004	10489	0.95%	218879	1.61%
	2005	10589	1.65%	222396	1.83%
	2006	10764	(average) 1.29%	226475	(average) 1.19%

Blackfeet and Related Areas: Counties of Glacier and Pondera					
	2000	8990	-0.50%	19671	-0.95%
	2001	8945	0.84%	19485	-0.18%
	2002	9020	0.62%	19450	0.10%
	2003	9076	1.18%	19469	0.75%
	2004	9183	0.73%	19615	-0.05%
	2005	9250	0.49%	19606	0.02%
	2006	9295	(average) 0.56%	19610	(average) -0.05%
Crow and Related Areas: Counties of Big Horn and Yellowstone					
	2000	11630	1.87%	142023	0.97%
	2001	11847	1.93%	143399	0.92%
	2002	12076	0.95%	144715	0.92%
	2003	12191	2.39%	146044	1.20%
	2004	12482	2.85%	147796	1.26%
	2005	12838	3.05%	149662	1.06%
	2006	13229	(average) 2.17%	151248	(average) 1.05%

Student Information: Percentages used to create the Percentage Pyramids

Population Percentage by Age Group and Reservation: The Little Shell Chippewa Tribe does have percentages by age group also, but is not included in this information.

Age Group	Montana Percent	Crow Reservation	Flathead Reservation	Fort Belknap Reservation	Fort Peck Reservation	Northern Cheyenne Reservation	Rocky Boy Reservation
0-4	6.1%	10.0%	7.1%	10.1%	8.6%	11.5%	12.0%
5-9	6.9%	10.2%	7.6%	11.1%	10.2%	12.1%	12.5%
10-14	7.7%	10.7%	8.8%	12.9%	11.1%	12.8%	12.5%
15-19	7.9%	10.3%	8.6%	11.3%	9.1%	10.6%	10.6%
20-24	6.5%	6.4%	5.2%	6.1%	5.5%	6.1%	7.7%
25-29	5.7%	5.3%	4.9%	4.9%	5.7%	6.6%	5.7%
30-34	5.8%	6.1%	5.4%	5.6%	5.4%	6.7%	6.2%
35-39	7.4%	7.6%	6.9%	7.6%	7.1%	6.6%	7.3%
40-44	8.4%	7.3%	8.0%	7.4%	8.3%	6.1%	6.4%
45-49	8.1%	6.3%	7.7%	5.8%	7.1%	5.2%	5.2%
50-54	6.8%	5.8%	6.6%	4.4%	5.4%	5.6%	3.6%
55-59	5.2%	4.2%	5.4%	3.3%	3.9%	3.4%	3.3%
60-64	4.2%	3.6%	4.6%	3.0%	3.2%	2.7%	2.2%
65-69	3.6%	2.4%	4.0%	2.4%	3.0%	1.8%	2.4%
70-74	3.3%	1.6%	3.7%	1.9%	2.5%	1.1%	1.1%
75-79	2.7%	1.3%	2.9%	1.3%	1.9%	0.9%	0.8%
80-84	2.0%	0.7%	2.0%	0.6%	1.6%	0.3%	0.5%
85+	1.7%	0.5%	1.9%	0.4%	1.3%	0.4%	0.2%

Teacher Information

This information is the difference between the total percentage of Montanans and each tribe. A negative value indicates that the tribal percentage in that age group was less than that of all Montanans. The standard deviation value represents the standard deviation for that age group.

Age Group	Crow Difference	Flathead Difference	Fort Belknap Difference	Fort Peck Difference	Northern Cheyenne Difference	Rocky Boy Difference	Standard Deviation
0-4	3.9%	1.0%	4.0%	2.5%	5.4%	5.9%	0.01659851
5-9	3.4%	0.8%	4.2%	3.3%	5.2%	5.7%	0.01603296
10-14	3.1%	1.1%	5.3%	3.4%	5.1%	4.8%	0.01448941
15-19	2.4%	0.7%	3.4%	1.2%	2.7%	2.7%	0.00939335
20-24	-0.1%	-1.2%	-0.3%	-1.0%	-0.4%	1.2%	0.00783976
25-29	-0.3%	-0.8%	-0.8%	0.1%	0.9%	0.0%	0.00572292
30-34	0.3%	-0.4%	-0.2%	-0.4%	0.9%	0.4%	0.00483038
35-39	0.2%	-0.5%	0.2%	-0.3%	-0.8%	-0.1%	0.00375261
40-44	-1.1%	-0.3%	-1.0%	-0.1%	-2.3%	-1.9%	0.00793263
45-49	-1.8%	-0.4%	-2.3%	-1.0%	-2.9%	-3.0%	0.00935149
50-54	-1.0%	-0.2%	-2.4%	-1.4%	-1.3%	-3.2%	0.00964459
55-59	-1.0%	0.2%	-1.9%	-1.3%	-1.8%	-1.9%	0.00744209
60-64	-0.6%	0.4%	-1.2%	-1.0%	-1.5%	-2.0%	0.00748328
65-69	-1.2%	0.4%	-1.2%	-0.6%	-1.8%	-1.2%	0.00697562
70-74	-1.7%	0.4%	-1.4%	-0.8%	-2.2%	-2.2%	0.00917058
75-79	-1.4%	0.1%	-1.5%	-0.9%	-1.8%	-1.9%	0.00691851
80-84	-1.4%	-0.1%	-1.5%	-0.4%	-1.7%	-1.5%	0.00615795
85+	-1.2%	0.2%	-1.3%	-0.4%	-1.3%	-1.5%	0.00601474